THE INSTITUTE OF PHYSICS
47 BELGRAVE SQUARE, LONDON, S.W.1.

BULLETIN

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The Bulletin is not intended for general circulation : your copy should not therefore be passed to a library.

APPOINTMENTS VACANT

The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might be offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.

Central Research Establishment, National Coal Board (at Isleworth, Middlesex) invite applications for superannuable appointments as **Scientists** and **Engineers.** Candidates should have a degree in physics, metallurgy, mechanical or electrical engineering or equivalent professional qualification, and preferably some experience in research.

The work embraces :—(*a*) the mechanical properties of coal ; (*b*) technical processes of winning coal from the seam ; (*c*) behaviour of the surrounding strata during and after removal of coal from the seam ; (*d*) design of experimental coal winning machinery embodying new principles ; (*e*) the transport of coal underground by belt conveyors ; (*f*) metallurgical problems arising in mining ; (*g*) environmental problems—(i) temperature and humidity conditions underground, (ii) the instrumentation of methane, (iii) the assessment and suppression of dust, (*h*) development of mechanical, electrical and electronic instruments for use in laboratory and underground. Much of this work will be carried out initially in the laboratory, although staff will be required to continue their experiments underground when required.

Salary on appointment according to age and experience, will be in the Scientist Grade III scale—£500 × £25 to £950 male, plus London Location Allowance of £34 minimum rising to £66 at maximum of scale.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/929. Original testimonials should not be forwarded. Closing date March 29, 1955.

Research Physicist for the **Grain Research Laboratory Board of Grain Commissioners for Canada, Winnipeg, Canada.** $4680–$5400. A research-minded physicist is wanted to work with Cereal Chemists on dough rheology in fundamental studies aimed at relating the physical properties of dough to breadmaking quality. Investigations will be undertaken on stress relaxation of dough and gluten, on fundamental interpretation of results obtained with practical dough testing instruments. This offers an excellent opportunity for original work. Applications to R. B. Griffiths, Personnel Selection Officer, Civil Service Commission, Ottawa, Canada.

A **Physicist** with industrial experience of instrument development is required to join a small team engaged in the design and manufacture of special-purpose apparatus. The work is concerned with a wide variety of physical principles and manufacturing techniques. A man possessing a general science degree, preferably including chemistry and with practical experience of mechanical and electrical engineering would be suitable. The appointment is at the Applicational Research Centre of a major Oil Company located near Chester. Staring salary according to age, qualifications and experience. Attractive Pension Benefits. Write giving full details experience, qualifications, age, marital status to Box ZT 705, Deacon's Advertising, 36 Leadenhall Street, London, E.C.3.

The British Boot, Shoe and Allied Trades Research Association requires two young **physicists.**

Post No. 1. For work on physical properties of shoes and shoe materials (e.g. moisture transmission and sorption ; elasticity and plasticity) and applications to (*a*) foot comfort problems (in collaboration with a physiologist) and (*b*) basic processes of the industry (e.g. lasting). Qualifications : at least 2 years' research experience, with proved ability in experimental and theoretical work.

Post No. 2. For practical research and development work on (*a*) footwear production and wear problems and (*b*) shoe materials. Recent graduates considered, but some laboratory experience (industrial or other) will justify higher starting salary.

Both posts offer good prospects in status and salary (no fixed ceilings). F.S.S.U. Applications to H. Bradley, C.B.E., Director of Research, Satra House, Rockingham Road, Kettering, Northants.

Rowntree and Company Limited invite applications for three senior appointments in the fields of Biochemistry, Physical Chemistry and Physics on the staff of a new Research Unit at York, the erection of which is now nearing completion. The men appointed should have high professional attainments in their respective fields and in particular should have initiative and the ability to handle their problems constructively. They will be expected to work co-operatively on the various projects under investigation ; the problems will be related to the Company's products and, while not academic in character, they will, nevertheless, be of a fundamental nature. It is hoped that ultimately one of these men will be appointed to head the Unit.

Men of exceptional calibre are being sought and the salary will be commensurate with these qualifications.

Appointments will qualify for participation in the Company's Pension Scheme, under which pensions equivalent to two-thirds of salary are achievable.

Letters of application should give, in confidence, full details of the applicant's age, training and career and should be addressed to : The Staff Officer (Men A.), Rowntree and Company Limited, The Cocoa Works, York.

A leading Company manufacturing industrial instruments and controls in the South London area require a **Development Engineer** and **Technical Assistant** to work on the development of novel instruments of an electronic and electro mechanical nature. For the former a degree in Physics or Electrical Engineering is required or equivalent professional qualification, while for the latter a Higher National Certificate in Applied Physics or Electrical Engineering is preferred. The applicants should preferably have had experience of development work in this or related fields. Please reply giving details of age, experience, qualifications and salary required to Chief Development Engineer, Box No. AV 73, The Institute of Physics, 47 Belgrave Square, London, S.W.1.

(*Continued on page iii*)

Commonwealth of Australia Division of radiophysics
Appointment Nos. 780/111–780/113 of **research officer**

The Commonwealth Scientific and Industrial Research Organization invites applications for research appointments to the Division of Radiophysics, which is located within the grounds of Sydney University. The Division has a modern and well equipped Laboratory and has vacancies in three recently developed fields of research : Radio Astronomy, a modern branch of Astronomy which is concerned with the study of extra-terrestrial bodies by means of the radio radiation which they emit ; Rain and Cloud Physics, an investigation of the physical processes which lead to cloud and rain, both natural and artificially induced ; the physics of Semi-conductors and in particular of Transistors, and their applications in Electronics.

Applicants should possess a University honours degree with physics as major subject and mathematics to a high standard. A good knowledge of modern electronic techniques would be a desirable but by no means essential advantage. Applications from recent graduates and from physicists with post-graduate research experience will be considered. Appointment will be made within the classification of Research Officer (salary range £A1184–£A1730 p.a.) and at a level depending on previous training and experience.

Those selected will be offered, according to their qualifications and experience, either :—

(i) A short term appointment (2-3 years), with the possibility of further extension ; or
(ii) A more permanent appointment to the research staff.

The appointments will be conditional on a satisfactory medical examination and officers appointed under (ii) may be granted superannuation privileges. Fares to Australia (including those of wife and family) will be paid.

Position 780/111—for work on radio astronomy.
Position 780/112—for work on cloud and rain physics.
Position 780/113—for work on transistors.

Applications referring to the appropriate appointment number and stating full name, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by names and addresses of two persons willing to act as referees, if required, and copies of not more than four testimonials, should reach the undersigned not later than March 26, 1955.

W. Ives,
Chief Scientific Liaison Officer.
Australian Scientific Liaison Office,
Africa House,
Kingsway,
London, W.C.2.

Assistant Technical Officers. Imperial Chemical Industries Limited, Billingham, have vacancies for several male physicist Assistant Technical Officers for interesting duties in their Engineering Research laboratories. These duties will entail contact with the manufacturing plants. Candidates should be not more than 28 years of age and should have a pass degree in physics. The posts carry a maximum salary of £950 per annum but initial salaries will depend on age and experience. Excellent conditions of employment are available including Staff Pension Fund. Write for application form, without commitment, to the Staff Manager, Imperial Chemical Industries Limited, Billingham Division, Billingham, Co. Durham, quoting Reference E.1.

Electrical Engineers. A large and well known industrial organization has vacancies for University graduates with experience in either power distribution or instrumentation. For the latter type of vacancy applications from physicists will be welcomed. These appointments offer excellent prospects of advancement to men of good technical ability who are seeking an appointment which offers speedy responsibility. Applications from men requiring post-graduate training leading to professional qualifications will also be considered, and normal salaries will be paid during such training. Starting salaries are in the range £600–900 per annum, depending upon qualifications and experience. Write, giving full details of age, qualifications and experience to Box AV 72, The Institute of Physics, 47 Belgrave Square, London, S.W.1, quoting Reference D.10.

Science **graduate** with degree or equivalent in physics, chemistry or chemical engineering and about four years' industrial experience is required for large, modern paper mill in Kent. Knowledge of statistical quality control an advantage. Previous experience in paper industry not essential. Excellent prospects. Pension Fund.

Apply in writing to the Personnel Officer, **Albert E. Reed & Co., Ltd.,** Aylesford Paper Mills, Larkfield, Nr. Maidstone, Kent.

Graduates of universities or professional institutions in engineering or physics required for research in high frequency, light current engineering, use of electrical equipment in inflammable atmospheres, electrical space and water heating. Permanent employment qualifies for F.S.S.U. or equivalent pension scheme. Starting salary £500–£750 according to qualifications. Applications to be addressed to the Director, Electrical Research Association, 5 Wadsworth Road, Greenford, Middlesex.

Research Chemists and **Physicists** with University degrees or equivalent and **Research Assistants** with Inter. B.Sc., or G.C.E. in science subjects are required by the Central Research Department of the **Morgan Crucible Company Limited** to take part in various projects of a varied and interesting nature. Scope exists for scientists and technologists interested in the relatively unexplored field of reactions between materials at temperatures between 1200°C and 2500°C, in powder metallurgy, in the field of semi-conductors, in the development of new physical testing methods, and in special problems associated with the physics and chemistry of carbon, graphite, refractory oxides, silicon carbide and metalceramics.

The laboratories of the department employ over 100 people and are modern and excellently equipped. Applicants called for interview will be given an opportunity to see some of the work going on, and good salaries dependent on age, qualifications and experience will be offered to men and women chosen to join an expanding department where there is ample scope for keen intelligence and practical commonsense. The laboratories are situated at Battersea and are accessible from most parts of London and the suburbs ; for those interested in furthering their studies, wide opportunities exist at Battersea or Chelsea Polytechnics which are only 10 minutes away. 5-day week, good recreational facilities and staff pension scheme. Please apply to The Staff Manager, The Morgan Crucible Company Limited, Battersea Church Road, S.W.11.

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JOURNAL SUPPLEMENTS

From 1951 *the papers presented at symposia arranged by the Institute, its Branches and Groups, have been or will be published as supplements to one of its monthly Journals—the Journal of Scientific Instruments and the British Journal of Applied Physics. Those taking a Journal regularly, automatically receive the supplements without extra charge.*

VACUUM PHYSICS

1951 15s. 0d.

PHYSICS OF LUBRICATION

1951 15s. 0d.

STATIC ELECTRIFICATION

1953 25s. 0d.

THE PHYSICS OF PARTICLE SIZE ANALYSIS

1954 35s. 0d.

LUMINESCENCE

(with particular reference to inorganic phosphors)

1955 25s. 0d.

THE INSTITUTE OF PHYSICS

Vol. VI, No. 3 **BULLETIN** MARCH, 1955

NOTICES TO MEMBERS

Payment of Subscriptions

Members have responded most readily to the request that 1955 subscriptions should be remitted with the form included in the January *Bulletin*. Much work and expense in the office have been avoided by dispensing with the individual reminders that have been sent out in previous years.

One or two members who pay by banker's order have requested receipts for these payments. Such receipts will always be supplied on request but individual notification of payments received through the banks is not otherwise made.

Conference Fees

Although the Board welcomes the increasing numbers of non-members who desire to attend the Institute's conferences, it has been concerned to ensure that they contribute toward the continually rising cost of these meetings. This cost has hitherto been met almost entirely by members' subscriptions. Instructions have, therefore, been given by the Board that, save in exceptional cases, persons who are not members of any grade shall be required to pay a minimum charge of £1 1s. 0d. for attendance at the Institute's conferences, including those arranged by its Branches and Groups.

Education Group Conference

The annual Conference of the Education Group will be held on April 14 and 15. The two main subjects for discussion are the teaching of thermodynamics (Prof. E. A. Guggenheim, Dr. G. G. Haselden, Prof. M. W. Thring, Dr. N. Kurti and Dr. R. S. Silver) and the place of physics in a liberal education (Dr. A. W. Barton, Mr. W. Llowarch, Prof. F. A. Vick and Mr. N. R. Hanson). On the evening of the 14th a social evening has been arranged ; on the 15th there will be a meeting in the form of "Any Questions." Members of the Education Group have received details and forms of application to attend. Other members of the Institute who would like to attend should write to the Deputy Secretary for particulars. Non-members of the Institute may take part, subject to the availability of accommodation, on payment of a conference fee of one guinea.

Non-Destructive Testing Group ; Summer Meeting

The Summer Meeting of the Non-Destructive Testing Group which is being arranged in conjunction with the Scottish Branch will be held in Glasgow from June 22–25 next. Some nine papers are to be presented and discussed and social functions and visits are being arranged. The programme with the form of application for attendance will be circulated shortly to all members of the Group and may be obtained on application by any other members of the Institute.

Electron Microscopy Group

The annual conference of the Electron Microscopy Group is to be held in Glasgow on July 5, 6 and 7. The content of the scientific programme is not yet settled, but forms of application to attend may be obtained from the Institute on request.

Industrial Spectroscopy Group : Additional Meeting

An additional meeting of the Industrial Spectroscopy Group has been arranged for Wednesday, April 27, at 5.30 p.m. in the Institute's House. The lecturer is Dr. A. G. Gaydon of the Imperial College of Science and Technology, London, and he will speak on " Spectroscopic evidence of the state of equilibrium in flame gases." Tea will be served at 5 p.m.

Student Monograph Series : The Theory of Lenses

The fifth booklet in the Institute's " Monographs for Students " series has just been published and is entitled *Theory of Lenses* ; the author is Mr. E. W. H. Selwyn (*Fellow*) of Kodak Ltd. Although this little book is about theory, its object is practical ; the author has attempted to deal with the subject with not much, if any, more mathematics than is acquired at a grammar school. The selection of problems that has been added are such that they cannot be solved by mere substitution in a correctly remembered formula.

This series is intended for general reading by students such as those in the first two years of a degree course in science or engineering or those reading for Higher National Certificates. Copies of the booklets may be obtained from any bookseller, price 5s. each, or direct from the Institute. Members of any grade of the Institute are entitled to copies at the reduced rate of 3s. 6d. each.

" Thermionic Valves 1904/1954 : The First Fifty Years "

On November 16, 1904, Professor J. A. Fleming (later Sir Ambrose Fleming) applied for a patent for his diode. The Jubilee of that event was celebrated by The Institution of Electrical Engineers at meetings

held on November 16, 1954, when there were three lectures, as follows :

Sir Edward Appleton, G.B.E., K.C.B., M.A., D.Sc., LL.D., Hon.F.Inst.P., F.R.S., on " Thermionic Devices from the Development of the Triode up to 1939."

Professor G. W. O. Howe, D.Sc., LL.D., on " The Genesis of the Thermionic Valve."

Dr. J. Thomson, M.A., D.Sc., F.Inst.P., on " Developments in Thermionic Devices since 1939."

These lectures are to be published in book form in about two months' time, together with the Opening Address by The Marquess of Salisbury, K.G., P.C., Lord President of the Council, and an appreciation of Sir Ambrose Fleming and Lee de Forest by Captain C. F. Booth.

The book, entitled " *Thermionic Valves : 1904–1954 : The First Fifty Years*," will contain about 48 pages of text and 32 pages of illustrations. The price to members of The Institute of Physics will be 4s. 6d. instead of 9s. 0d., the price to the general public.

Orders from members with remittances should be sent to The Institute of Physics and not to the Institution of Electrical Engineers.

English Translations of Russian Papers in Physics

At the request of the American Institute of Physics, an enquiry has recently been made by our Institute and The Physical Society jointly about the likely demand for English translations of Russian papers on pure and applied physics. Copies of the enquiry circular and questionnaire may still be obtained from the Secretary of our Institute on request.

In the meantime some members may be interested to learn that Columbia Technical Translations of 561 West 141st Street, New York 31, N.Y., announce a complete cover-to-cover translation of the *Bulletin of the Academy of Sciences of the U.S.S.R.—Physical Series*, beginning with Vol. 18, No. 3. This *Bulletin* generally publishes reports presented at Soviet All-Union conferences on various topics in the field of modern physics. Hence each issue, running to 100–150 pages, includes both theoretical papers and contributions on experimental research. The translation will be reproduced from typewritten copy by offset printing and on microfilm. Microfilm subscribers will also receive an offset copy of the Table of Contents with each issue to facilitate reference and indexing. The subscription price is $110 for the offset edition and $95 for the microfilm edition. Offset subscribers desiring a microfilm copy for their permanent collection can obtain this with their subscription for an additional $25 per year.

Subscriptions will begin with Vol. 18, No. 3, which is now in process of translation. This is the first of two issues devoted to ferrites.

Special arrangements have been made to receive the *Bulletin* as promptly as possible upon publication. However, since Soviet journals do not have fixed publication dates, in case future issues are greatly delayed it is intended to go back to Nos. 1 and 2 (devoted to beta- and gamma-ray spectroscopy). Otherwise current subscriptions will run through Vol. 19, No. 2.

The Physical Society's annual exhibition of instruments and apparatus

The Physical Society's 39th annual exhibition of instruments and apparatus will be held in the New Hall of the Royal Horticultural Society, Westminster, London, S.W.1, from April 25 to 28, 1955 (inclusive). The exhibition will be open from 10 a.m. to 8 p.m. on April 26 and 27 and from 10 a.m. to 5 p.m. on April 28. Although it will also be open until 8 p.m. on the first day (April 25) the morning (10 a.m. to 2 p.m.) has been reserved for the Press and Fellows of The Physical Society.

It has been agreed to offer special tickets to members of sister institutions, including The Institute of Physics, to enable them to visit the exhibition on The Physical Society members' morning, Monday, April 25, when the exhibition is not so crowded. Tickets for admission, which are available for any one day, may be obtained by members from the Institute.

Joint conference on combustion

The Institution of Mechanical Engineers announces that it has arranged a joint conference on combustion with the American Society of Mechanical Engineers which will be held in Boston, Massachusetts, from June 15 to 17 next and in London from October 25 to 27 next. The objects of the conference will be :

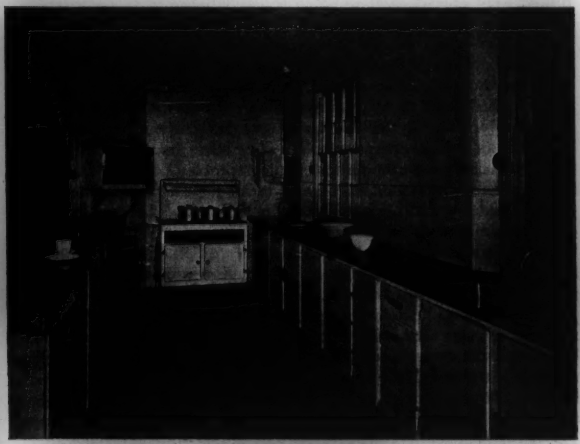
(i) to link theory and practice in this sphere by presenting the results of theoretical work to practical engineers in America, Great Britain and other countries ; and

(ii) to provide an opportunity for practical engineers in these countries to meet together to discuss practical application of theory in the fields of boilers, furnaces, internal combustion engines and gas turbines.

Some thirty other institutions and societies, including The Institute of Physics, are supporting the conference and their members may obtain particulars and preliminary reply forms through these bodies.

GIFT FOR THE INSTITUTE'S HOUSE

In the *Bulletin* of June, 1954, it was announced that three gifts to the Institute had been offered through the good offices of Sir Hugh Warren (*Fellow*), Managing Director of Associated Electrical Industries Ltd. One of these, made through Dr. T. E. Allibone (*Fellow*) was referred to in the last issue of the *Bulletin*. The Board is now glad to acknowledge with gratitude a second gift, made through Dr. Willis Jackson (*Fellow*) of the Research Laboratory of Metropolitan-Vickers Electrical Co. Ltd. This, a sum of money, has been used for the re-equipment and re-design of the kitchen of the Institute's House. The catering facilities of the Institute are much appreciated by the many members who attend the lectures, conferences and social functions arranged by the specialist Groups and the London and Home Counties Branch and this generous gift is a most useful contribution to this side of the Institute's activities.



The re-equipped Kitchen

BRITISH ELECTRICITY RESEARCH LABORATORIES

By J. S. Forrest, M.A., D.Sc., F.Inst.P.
(*Director*)

Research on a national basis by an electricity supply authority started in 1930 when the Grid system was being put into operation. The Central Electricity Board, the body then responsible for operating the Grid system, soon found it necessary to establish a laboratory to study the problems arising from putting into service for the first time in this country an extensive network of 132kV transmission lines.

It became apparent in a few years' time that there was a great deal of scope for research on high-voltage transmission problems and plans were made to build a larger laboratory for this work. It was never possible for the C.E.B. to start on this project, however, owing to the difficulties of the war and the post-war years. With the nationalization of the electricity supply industry in 1947, the C.E.B. organization was taken over by the British Electricity Authority, and as the 1947 Electricity Act placed considerable emphasis on research, the B.E.A. were able to start work on a new laboratory at Leatherhead largely on the lines originally conceived by the C.E.B.

The new laboratory was completed in 1950. It served as the central laboratory of the British Electricity Authority and the fourteen Electricity Boards so that its scope was much wider than that visualized for the C.E.B. laboratory which was concerned only with transmission. Accordingly, although the laboratory served a useful purpose during the first years of B.E.A. operation, plans were soon made to extend it so that chemical, physical and mechanical problems arising in power stations could be more effectively tackled. The extensions were finished and put into operation early in 1955. Fig. 1 shows the completed building ; the three-storey extension wing can be seen on the right of the main building.

In the design of the extension, advantage was taken of experience gained from the main building, and certain changes were made to provide increased flexibility in operation, greater convenience for the research workers and lower initial and maintenance building costs. The inside of the main walls is of ivory sand-lime fair face bricks except for a height of three feet from the floor which is in dark purple flint facings. Cream-coloured steel sectional partitions, glazed where necessary, are used to form the individual laboratories and corridors. The permanent services—electricity, gas, water and compressed air—are run in accessible ducts and pipes on the walls. For the electricity supplies, standard-size boxes are used throughout, either mounted on the walls or built in to the benches. Several standard types of panel can be fitted in these boxes to provide 13-ampere a.c. socket outlets ;

Fig. 1 — General view of the Laboratories

3-phase a.c. ; variable voltage a.c. ; d.c. from a central battery ; and earth terminals. The investigator can then choose the arrangement which is most suitable for his work. In addition, a system of overhead perforated trays runs throughout the building so that any wiring or other experimental services, which may be required in future, can easily be installed. Fluorescent lighting is used, except in the dark rooms, and provides an intensity of 20 foot-candles at the bench tops. The building is heated by electrically-warmed floors, the air temperature being thermostatically controlled. This system has the advantages of making use of the heat storage capacity of the floor and of saving the wall space which would otherwise be required for radiators. A unit system of furniture has been adopted with inter-changeable cupboards and tiers of drawers. A coloured-light staff location system has been installed to reduce the time which is otherwise wasted in trying to find people. In Fig. 2, a view of the General Physics Laboratory, the electrical supply panels (in the ends of the benches), the overhead trays and the staff location indicator (near the clock) can be seen.

The total floor area is about 30,000 ft.^{2} The laboratory is not yet fully staffed but the present staff numbers 80, of which 40 are qualified engineers, physicists or chemists.

It is the aim of the Laboratories to be able to contribute to the solution of any of the manifold problems which may arise in the generation, transmission and distribution of electricity. These problems usually have their origin in breakdowns in service or in operational difficulties, and the immediate object of the research is to find a cure for the trouble as quickly as possible, and in general to improve the efficiency and reliability of the electricity supply. Such work, however, often provides the raw material for research of a more fundamental nature and the results of this work may in turn be applied to practical operation.

Fig. 2 — General Physics Laboratory

The scope of the work is necessarily very wide involving anything from the mechanics of the grinding of coal for a pulverized-fuel furnace to the measurement of acoustic noise emitted by electrical plant. However, practically all the routine laboratory work, such as the testing of coal, water and oil, and the calibration of instruments and meters is done by the local power station laboratories and Electricity Board test departments. It is possible therefore for the Central Laboratories to devote all their resources to research in the true sense of the word.

In order to deal with the wide scope of this work the laboratories are divided into the following six subject sections : Transmission and Distribution ; Electronics and Instruments ; Generation ; Mechanical

Engineering ; Physics ; and Chemistry. In addition, there are Photographic and General Services Sections, a Drawing Office and a central Workshop which provide common services for the laboratories. A Library, Reading Room and Conference Room are also provided.

The main object of the sectional sub-division is to facilitate more effective detailed supervision of the work, but apart from this the Sections work together very closely on specific problems. In fact the main strength of the organization arises from the wide range of knowledge and experimental techniques available under one roof, and the most effective attack on a problem is often made by a small team including physicists, chemists and engineers.

A brief account of the functions and work of the Laboratories is given below. It should be mentioned that the Authority also contributes on a large scale to co-operative research by Research Associations and other bodies, and also supports research at Universities, but these matters are outside the scope of the present article.

TRANSMISSION AND DISTRIBUTION

The Transmission and Distribution Section is concerned with research in connexion with the design and operation of the main 132 kV and 275 kV Grid transmission system and also the lower-voltage distribution systems of the Electricity Boards. The high-voltage laboratory is equipped with a 1400 kV impulse generator which is used in the study of the effects of high-voltage surges produced by lightning or by switching operations (Fig. 3). Equipment providing up to 250 kV a.c. and 200 kV d.c. is also available together with apparatus for oscillography, and measurements of dielectric power factor and discharges in insulation. The measuring equipment and controls are built into a control desk and the operators are protected by a screen with toughened glass panels and electrical interlocks on the doors which give access to the high-voltage area. The enclosure of the control desk also serves to deaden the noise of the impulse generator discharge which is unpleasant for the operators, particularly as, in such work, a large number of "shots" are nearly always necessary. A feature of the control desk is that the scales and pointers of the instruments are painted with fluorescent paint and illuminated with ultra-violet light so that the instruments can be read in darkness—this is useful when observations of visual corona are being made.

Other laboratories are provided for low-voltage work, and for research on cables, insulating materials and components. Some interesting observations have been made on the effect of traces of water and other impurities, such as metal-organic compounds,(1)(2) on the electrical characteristics of insulating oils. Work is continually in progress on the examination of insulating components which have

failed in service, and methods of test are developed to detect faulty insulation at an early stage, and thus avoid a complete breakdown, and possibly an interruption of the electricity supply.

Fig. 3 — Impulse generator showing 1-million volt spark discharge

Many high-voltage transmission problems can only be investigated effectively by using a full-scale transmission line—for example, the corona power loss in various weather conditions or the radio interference radiated from the line. For such work an experimental transmission line has been erected near the laboratories. It consists of three

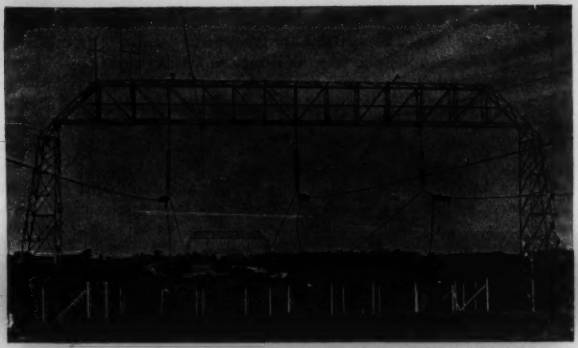


Fig. 4 — High-voltage experimental line

steel gantries 1200 ft. apart from which various arrangements of line conductors can be suspended (Fig. 4). The line is supplied from three step-up transformers which provide voltages for research on 275 kV and 380 kV transmission problems.[3]

Another important problem, particularly in this country, is the development of high-voltage insulators which will operate satisfactorily in humid and polluted atmospheres. Here again it is difficult to simulate the service conditions in the laboratory, and the most satisfactory method at present of studying this problem is to take observations on full-scale insulators operating outdoors in typical polluted atmospheres. This work is carried out at Croydon Testing Station, where steel towers and gantries are provided on which insulators can be erected and their characteristics measured at voltages of up to 250 kV.

ELECTRONICS AND INSTRUMENTS

The work of the Electronics and Instruments Section includes the development of special instruments and the application of electronic techniques to power system operation.

A modern interconnected transmission system requires an equally extensive system of communication lines for its control. These lines are used for telephone and teleprinter messages, and for the remote indication of switch positions and meter readings, and there is considerable scope for the development of suitable signalling techniques which make the best use of the available channels. Measurements at radio frequencies are often required in connexion with communication

facilities or in the study of radio interference from transmission lines, and measuring sets are available for a frequency range of from 0.1 to 150 Mc/s. Audio-noise measuring equipment is also used to investigate the noise emitted by transformers and other plant, and vibration measurements are of importance in large machines. The British power system is controlled manually at present but there is considerable scope for the development of methods of automatic control, the ultimate goal being to control both the boiler plant and the electrical generators to meet the load demand at the time while maintaining a constant frequency, and also a pre-arranged transfer of load over certain interconnectors. This work involves the development of special devices for the measurement of frequency and load and the rates-of-change of these quantities.

A specialist workshop equipped for the production of electronic instruments designed in the Laboratories is attached to the Section.

The Electronics and Instruments Section also provides an instrument service for the Laboratories ; this is an important function, as it is necessary to store, issue, and maintain a diverse collection of about 800 instruments.

Many investigations have to be made in the field, in switching stations or power stations, and for this work a mobile laboratory with a photographic dark-room trailer is available.

GENERATION

The Generation Section was established to study certain specific problems associated with operating difficulties. For example, it was desired to prevent the precipitation of moisture in the vicinity of water cooling towers as this caused a nuisance, particularly when the water froze on the streets in cold weather. A small-scale experimental cooling tower was erected at Croydon Testing Station to investigate the carry-over of the water droplets and this work led to the design of an efficient louvre system which cured the nuisance. As a by-product of this work, useful design data were obtained on the heat transfer from water droplets to air, and on the pressure drop in various types of cooling tower packing.(4)(5)

Another interesting research now in progress is on the fundamental mechanism of electrostatic precipitation.(6) Electrostatic precipitators are used to prevent the emission of dust from power station stacks, and although they have been developed empirically to a high state of efficiency, there is a surprising lack of knowledge on such questions as the effects of the voltage waveform, the shape of the high-voltage electrode, and the resistivity of the dust. To investigate such factors a tubular pilot plant has been erected in which the voltage and current

Fig. 5 — Tubular-type Electrostatic Precipitator Pilot Plant

conditions, the electrode system and the dust characteristics can be controlled separately (Fig. 5).

MECHANICAL ENGINEERING

The work of the Mechanical Engineering Section includes the testing of materials, the mechanical characteristics of transmission-line conductors and insulators, and vibration problems.

A special 12-ton testing machine is available for measuring the ultimate tensile strength of 10-ft. lengths of overhead-line conductor and the associated joints. For more general work on materials, a 50-ton universal machine, a 150-ton compression machine, an Izod impact tester, two small 2-ton hand machines, and hardness testing equipment are provided.

Samples of overhead-line conductor taken from the Grid system in various parts of the country are examined to ascertain the loss in mechanical strength. In this way data are obtained on the service life of the conductors and on the types of corrosion experienced, particularly in coastal and industrial areas.(7)

Work is also carried out on the utilization of fly ash (the finely-divided ash from pulverized-fuel-fired boilers) as a partial replacement for cement in mass concrete.[8]

A workshop equipped with the usual machine tools is available for the production of prototype apparatus and research equipment designed in the Laboratories.

PHYSICS

Physics is the basic subject in many aspects of power station operation, such as combusion, flame radiation, heat transfer, fluid flow, particle size analysis, and the dispersion of dust and gases from chimney stacks—to take a few examples from the boiler plant. In recent years the advent of nuclear power is enlarging still further the scope of the physicist in the electricity supply industry.

In addition to the General Physics Laboratory (Fig. 2), there are separate laboratories for Heat, Light, Radiography, X-Ray Diffraction, Radiation and Particle Mechanics.

The ash from pulverized-fuel boiler plant is a complex mixture of particles of shale, magnetite and unburnt carbon having densities of from less than 1 to about 5 g/cm^3. The most important factor in determining the behaviour of this dust is its terminal velocity in air, and accordingly apparatus has been developed to grade dust samples directly in terms of terminal velocity.[9]

Work is also in progress on the fuel cell—a device for converting the chemical energy of a fuel into electrical energy without an intervening steam cycle.[10][11] Most of this work is carried out at universities and other research organizations but the work is co-ordinated by the Research Council of the B.E.A.

Semi-conductors are studied in connexion with the use of semi-conducting ceramic glazes to improve the performance of insulators. Furthermore, semi-conductors are of interest as, like the fuel cell, they may in the future provide more efficient energy-converting processes than the steam cycle.

Meteorology is important in many aspects of power system operation. The demand for electricity is affected by the air temperature, the wind speed, and the daylight intensity. Breakdowns on overhead lines may be caused by thunderstorms, gales, ice and pollution. The corona power loss on the highest voltage lines depends on the rainfall. Accordingly a meteorological laboratory has been provided and equipped with instruments to give weather data of interest in other investigations. A workshop is also attached to the Physics Section.

CHEMISTRY

The chemical laboratories consist of a General Analytical Laboratory and a Physical Methods Laboratory equipped with a Hilger large

spectrograph, a polarograph, a photo-electric absorptiometer and a flame photometer (Fig. 6). In addition there are separate specialist laboratories for Corrosion and Metallurgy, Oil, and Ceramics.

The Chemistry Section provides an analytical service for the other Sections and also develops special analytical methods for routine use in power station laboratories. An important part of the work of the Section is the study of the formation of deposits which build up on the fire-side of the heating surfaces of boilers. These deposits block the gas passages and reduce the heat transfer so that the boiler has to be shut down and cleaned. From a knowledge of the factors which affect the rate of formation of the deposits, such as the presence of alkali-metal compounds in the coal, it has been possible continually to increase the " availability " of the boiler plant. In addition, research is in progress on the corrosion of steels at high temperatures, the corrosion of overhead-line conductors and underground cables, and on various problems in metallurgy and ceramics.

Fig. 6 — Physical Methods Analytical Laboratory

Work is also being carried out on the oxidation of insulating oils. Electrical oils after some time in service at high temperatures may oxidize with the formation of acids and sludge, and many accelerated tests have been proposed to assess the performance of oil in service. The pressure-oxidation test which originated in the United States has recently been studied.(12) In addition, apparatus has been constructed to give a continuous record on a chart of the absorption of oxygen by

an oil sample. This apparatus is particularly valuable in assessing the effectiveness of anti-oxidants or "inhibitors"—small quantities of substances, such as di-butyl-para-cresol, which stop the oxidation chain reaction.

PHOTOGRAPHY

Photography is a powerful scientific tool in itself—for example, in the study of arc and spark discharges. It is also important as an auxiliary in many techniques, such as oscillography, spectrography, radiography and photomicrography. In addition, photographs of instruments or of breakdowns of plant are required for record purposes and for reports. A photocopying service is essential to provide quick reproduction of printed documents and drawings. Ciné photography is often invaluable, and frames taken at normal speed, high-speed or at long intervals all have their special applications. The ciné camera is also used to record a large number of observations at the same time by photographing a number of instruments assembled on a panel, sometimes automatically in the absence of any human observer.

The Photographic Section carries out all these operations and is adequately equipped to ensure that high-quality work can be done quickly. A General Purpose Darkroom is provided together with separate darkrooms for negatives, X-ray films, and photocopying. There is also a room for print finishing and a store.

In conclusion, it is hoped that it has been possible in this short article to give a picture of the organization and work of the Research Laboratories of the British Electricity Authority. As far as the physicist is concerned, it is clear that in this work there is great scope for physics, physical techniques, and above all, the basic physical method of approach to new problems. In a modern industry founded on scientific discoveries advantage has already been taken of existing scientific advances and so there is not likely to be any easy solution of present operational problems or sensational increases in efficiency. However, even a very small fractional improvement in efficiency in an industry costing £300 million a year will pay for the cost of research many times over.

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REVIEWS OF BOOKS

Calculations in physics. By W. Ashhurst and H. A. Hornby. (London: John Murray (Publishers) Ltd.). Price 10s. 6d. Pp. 211.

Advanced level examples in physics. By R. V. Johns and W. F. Ware. (London: Macmillan & Co. Ltd.). Price 16s. Pp. 346.

These two collections of examples, both of Advanced G.C.E. or Intermediate standard, should serve a useful purpose in schools, especially in the revision weeks before examinations. Most of the problems are of the ordinary straightforward type within the compass of the average candidate; and in each book typical examples are worked and fully prefaced by a brief statement of the principles involved. The lay-out and presentation of these quite dignified books should carry the conviction that this aspect of the work is important, and can be interesting also. Pupils who have won admission to an Advanced course cannot really find numerical problems difficult; sums are simply unattractive by comparison with the rest. Bread-and-butter is to be sampled sparingly (rejecting the crusts) so as to leave room for the meringues. The simple and digestible fare offered here gives the pupil no alternative or excuse. And those in genuine need of assistance will find these books to be two generous helpings.

G. R. Noakes.

The teaching of electricity. A report of a sub-committee of the Science Masters' Association. (London: John Murray (Publishers) Ltd.). Price 10s. 6d. Pp. xii, 135.

The teaching of electricity is at present undergoing an important change, in that the three previous sets of units, electrostatic, electromagnetic and practical, are being replaced by units based upon the metre, kilogramme and second (M.K.S.). This book is a report by a sub-committee of the Science Masters' Association, formed to consider how the teaching of electricity in schools will be affected by the use of the M.K.S. system. The committee makes two independent recommendations, namely that the rationalized M.K.S. system should be adopted and that all quantitative treatment of magnetic poles be omitted from school syllabuses.

The book follows up these recommendations by outlining a new teaching syllabus, including teaching notes together with a complete set of definitions and theoretical proofs. These are particularly helpful to those who are more familiar with the classical c.g.s. approach. The final chapter describes experiments devised by the late F. A. Meier, around which the new syllabus has been built. Valuable details about how the apparatus may be constructed are also provided. It might be

added for the benefit of the busy schoolmaster that this apparatus will soon be available commercially.

The committee has been careful to point out that this is not the only approach available, and in particular the development suggested by Tricker in the *School Science Review* for June and November, 1954, might profitably be compared with the approach recommended in this book.

This report should prove most helpful, especially since very few books based upon the M.K.S. system are at present available in this country. No one responsible for the teaching of electricity above Ordinary level of the G.C.E. can afford to be without a copy.

T. A. LITTLEFIELD.

Introduction to Atomic Physics. By OTTO OLDENBERG. (New York : McGraw-Hill Book Company). Pp. xiii + 421. Price 48s. Second Edition.

This is a very good book rather more fitted to American teaching practice than to British. It is designed for students who have attended one year's classes in general physics, but by our usual practice such students are more competent in mathematics than Oldenberg requires his readers to be. On the other hand, the subject matter covered is a good deal more extensive than we normally attempt in any one year's course. The aim of presenting explicitly those fundamental arguments which are too often taken for granted is satisfactorily achieved in the early part of the book, but in the later chapters the discussion in the text is hardly quantitative enough. This fault is redeemed for the more zealous reader by the examples provided, with a certain amount of hints and discussion, at the end of a chapter.

The changes from the first edition are of variable quality. The new section on solid state physics is far too cursory, and the additions to the nuclear physics sections, although well done, are not really very extensive, as is natural in a comparatively elementary book. The increase in the number of examples is the most important improvement in the new edition.

Anyone who teaches atomic physics will find the book useful. A good course for first and second year students can easily be constructed from it by selection and expansion to the lecturer's individual taste. An interesting list of lecture and laboratory experiments, with appropriate references, is given in an appendix.

Students will find the book valuable both for course work and reading round the edges of the course. Many of the examples might be useful to senior undergraduates (and even, if I dare say it, post-graduates) who often find disappointing difficulty in dealing with

problems much simpler than the examination questions that are usually set them.

The price is not unduly high, as books go nowadays. The book is well produced and the binding satisfactorily sturdy. It can be recommended especially to teachers and students.

G. A. P. WYLLIE.

NEWS OF MEMBERS

Fellows

DR. R. BEECHING is now Metals Division Chairman of the Imperial Chemical Industries Limited.

R. W. DOUGLAS will take up an appointment as Head of the Glass Technology Department of the University of Sheffield as from September, 1955, in succession to PROF. H. MOORE.

DR. B. P. DUDDING (*Honorary Secretary*) has been awarded an honour by the Italian Government in recognition of his services to the Italian glass industry. The title of the award is " Ufficiale of the ' Ordine al Merito della Repubblica Italiana '." Dr. Dudding was president of the Society of Glass Technology in 1934–36 and of the Second Congress on Glass held in England in 1936.

DR. H. L. PENMAN has been appointed Head of the Physics Department of Rothamsted Experimental Station.

DR. R. K. SCHOFIELD is now Head of the Chemistry Department of Rothamsted Experimental Station.

DR. C. SYKES (*Past President*) is to receive the honorary degree of D.Met. of the University of Sheffield.

PROF. W. E. S. TURNER has been invested with the insignia of a Commendatore of the Order of Merit of the Republic of Italy. This is in recognition of his services to the glass industry; for thirty years he was Honorary Secretary of the Society of Glass Technology (from its inception in 1916) and was President of the Society in 1922–24 and 1937–38. He was President of the International Commission on Glass from 1933 to 1953.

Associates

A. H. ANSTIS is now Senior Scientific Officer with the Ministry of Supply.

G. A. BASSETT has taken up an appointment with Tube Investments Research Laboratories.

H. W. BENNETT is now a Lecturer at Loughborough College of Technology.

DR. R. A. BONES will shortly be taking up an appointment as Lecturer in Physics in the University of Hong Kong.

DR. A. CHARNLEY is now at the Royal Technical College, Salford.

DR. G. K. EATON is now Senior Scientist at the Mullard Research Laboratories.

DR. D. EVANS is a Research Fellow at the Imperial College of Science and Technology, London.

DR. C. D. MEE is now with M.S.S. Recording Company Limited, Colnbrook.

M. MICHAELIS has been appointed co-ordinator of civilian atomic energy projects by Arthur D. Little Inc., Cambridge, Massachusetts. He would be glad to hear from any Fellows or Associates who may be going to the U.S.A.

G. B. F. NIBLETT has been promoted to Senior Scientific Officer in the Weapons Division of the United Kingdom Atomic Energy Authority.

E. H. RHODERICK has been appointed Principal Scientific Officer at Services Electronics Research Laboratory.

Graduates

B. BURGESS is now a Scientific Officer in the Royal Aircraft Establishment, Farnborough.

L. R. GRAY has been promoted to Senior Scientific Officer at the R.N.S.S., Admiralty Signal and Radar Establishment, Portsdown.

J. P. HAGGART is now employed as a Technical Assistant by the International Business Machines (United Kingdom) Limited.

L. D. HARDY is now employed with John Heathcoat and Company Limited, Tiverton.

P. HUMPHREYS is now a Microwave Engineer at the Electric and Musical Industries Engineering Development Limited, Middlesex.

J. LUFF is Senior Lecturer at Stockport College.

DR. D. D. RANDALL has been appointed Technical Officer in the Research Department of Imperial Chemical Industries Limited, Stevonston.

A. WOMERSLEY is now on the staff of The Manchester Grammar School.

P. WOOD is employed by the British Tabulating Machine Company Limited as an electronics development engineer.

K. WRIGHTS is now an Assistant Experimental Officer at the Mechanical Engineering Research Laboratory, East Kilbride.